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at the American Association for the Advancement of
Science

*Science and Power:
A New Commitment for the 21st Century*

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Ladies and Gentlemen,

I am deeply honoured to have been invited to address such an eminent gathering and to have this opportunity to examine the issues of knowledge and responsibility with you. We have a particular duty to examine their complexity in the contemporary setting. More than that: we have to anticipate the likely impact of those issues in the future. Prevention may be practically invisible, but it is the only real victory. It does not "defeat" suffering - it averts it! I like to say that science is placed permanently in a watchtower, from which it can scrutinise the future. The past cannot be re-written, it can only be described. But we can write the future and to write the future differently, science is indispensable.

In this talk, I want to sketch the outline of the relationship between science and power, and of the type of ethical commitment required for the twenty-first century. What I hope to be able to do, is to give you some idea of my concerns, as Director-General of UNESCO and as a biochemist, and also give you an idea, not only of what UNESCO is doing in this field, but of what we can do together to carry our long-standing cooperation forward.

Before I start to discuss power *and* science, I would like first to take a look at the power *of* science. I believe the greatest power of science - indeed the reason that we simply cannot do without science today - is its ability to change the quality of life. I know I do not need to recall in detail for this audience all the outstanding achievements of science. The fact is today, that many diseases dreaded in the past are now virtually unknown to present generations. The fact is that untold millions of people have been released from exhausting, repetitive tasks although that does not avert the new risk, in our cyber-age, of people becoming "screen-driven", with no time to think creatively. When no-one has time any more to think what nobody has thought before, then will homo sapiens sapiens become homo virtualis? Nevertheless, our horizons have been broadened, our lives in many ways have been enriched, thanks to beneficial applications of science - for those of us fortunate to have access to them and the problem of unequal access is one I will return to.

Looking back, we can say that science has been successful - but its applications less so. Earlier this century, a horrified world witnessed the perverse and destructive capacity of certain scientific applications, its power to destroy life on a scale unknown, its power to destroy planet Earth as we know it. Science has now added to these capacities, the power to modify life - to alter the genetic heritage of any species, including the human species. Even if some limits are set, for example with a ban

on human reproductive cloning, this leaves intact huge problems raised by life-changing science.

Let us take the example of transgenic organisms. To what extent can we say that a species-specific genome is "inadequate"? This means setting science above nature, which gives each species a specific genome. One may say "yes" to some transgenic organisms, giving the go ahead only for evidently beneficial ones: beneficial in the sense of reducing or preventing human suffering. "Yes", perhaps, for drought-resistant subsistence crops, once the different facets of the new crops have been thoroughly investigated. There has to be a full risk assessment. Other matters have also to be faced: ethical issues, social and economic issues, issues of North-South disparity, scientific issues such as restrictions to the free circulation of knowledge.

Let us take another example: will the mapping of the human genome entail a redefinition of health? Is our concept of health no longer to be based on a feeling of fitness, on the absence of illness? As we move on from curative and preventive medicine to predictive medicine, does "health" become a rare state reserved only for those lucky enough to have no genetic predisposition to illness? And what then happens to all the others, in their work, in their private lives?

In posing these questions, I am reminded of the comment of American sociologist Edgar Friedenberg, when he wrote in the 1950s: *"Only science can hope to keep technology in some sort of moral order."* With a similarly sceptical attitude to technology, the Mexican poet Octavio Paz wrote in the 1970s: *"Why?" and "To what purpose?" are questions that technology does not ask itself.* Is science the answer? I vividly remember Sir John Daniel, Vice-Chancellor of the Open University of the United Kingdom, starting a lecture with great irony by saying: *"Ladies and Gentlemen, technology is the answer. What was the question?"*

At the end of the 1990s, can we separate science and technology as neatly as Friedenberg did? Indeed, can we make a neat distinction between "pure" and "applied" science? We are increasingly witnessing a dynamic interaction between the two. Professor Bernardo Houssay, the Argentine winner of the Nobel Prize for Medicine, once said to me - and this remains as true today: *"There is no applied science if there is no science to apply"*! Now that we witness the power of science to transform life-forms, culture, the economy and society, we can echo Octavio Paz by saying science **must** ask "why?" and "to what purpose?". It cannot have an ethic of no ethics.

Science must be utilized much more than it is to alleviate human suffering: to respond to dramatic environmental changes, for example. We have very powerful alliances for the defence of our frontiers. The most sophisticated technologies, based on the most recent scientific discoveries, are utilized. What alliances do we have for the defence of our air, our water, our soil, our health? Do they not deserve protection, when they face potentially irreversible damage? The risk of irreversibility places a particular responsibility on us: We must apply an ethics of time. If a major risk appears imminent, it is not the time to commission a report or start another survey - it is time for action! A reporting society is a postponing society.

Here then, are some of the problems raised by and facing science today. Fortunately, there are other factors at play which counter some of the difficulties. To tackle complexity, we can turn to the power of interdisciplinarity. The so-called hard sciences and the social sciences are coming together in many areas where synthesis rather than reductionism is seen as the most promising approach. Einstein once said: *"Everything should be made as simple as possible. But not simpler"*. Big problems can only be solved with big solutions. The scale of some crises is such, that the only answer is to "think big". The Aral Sea is one example: the problems of its inflow and outflow have to be dealt with as a whole - and with the several billions of dollars needed to have an impact. In the case of human health, a massive and concerted effort is needed to find solutions to problems like malaria and the newly-emerging, prion-like diseases.

In short, a new political thinking is required; one where radical action, large-scale action and timely action become the natural response to critical problems. I believe another positive factor which helps us counter the complex difficulties of the world today, is that many scientists themselves have carried out a radical reassessment of their role and responsibilities. Researchers now engage in public debate. They accept ethical, social, legal and political questioning of the implications of science.

All of these trends give a formidable new impetus to the advisory role of science. More than ever, governments and parliaments need sound scientific advice on which to base policy decisions. I well recall the forced silence of the scientific community when I visited the Soviet Union from the 60's to the 80's. A regime is condemned if it does not give its own experts the freedom to speak! Yes: more than ever, the voice of the scientists must emerge. Science and scientists are gearing up to that crucial role.

Ladies and Gentlemen,

The relationship between science and power must be seen within the context of what is called "globalization". Unfortunately, it is only a partial and asymmetrical globalization, particularly in the case of trade and telecommunications. 600,000 villages without electricity represents at present a very unbalanced "globalization" of the media: it means 600,000 villages where no-one can plug in and switch on. Concerning trade, if we try to identify the real beneficiaries of the triangle formed by knowledge, production and trade, we realize that the present gap is not narrowing. We see a very dangerous concentration - at the global level - of wealth and power in fewer hands. This entails the widening of misery, frustration, radicalization, violence.

These are dangerous trends. In our rapidly changing world, it is therefore essential that decision-makers face up to complexity. To do that, they need impartial but also comprehensive assessments based on scientific rigour. Many of the problems facing decision-makers are global, or, at the very least, regional in nature. This has important implications for the nature and organization of science's role. At UNESCO, we are used to dealing with issues like the environment, genetic diversity, climate change or freshwater resources on a global scale. Globality is required when problems are global - globality of researchers' input, of data gathering, of monitoring phenomena, of information exchange. After all, the scientific community formed the first global village. Scientists are also very familiar with the endless diversity - the uniqueness! - of life, at the personal, social and cultural levels.

However, in spite of the endless diversity of human experience and situations, uniform remedies have been applied too often to different social, cultural and economic situations. You are well aware of the results: a vicious circle of loans, repayments and indebtedness, often crippling new democracies. The recognition of diversity is a very important role of the scientific community. "Globalization" and the pressure it puts on governments to follow market-driven, competitive, profit-oriented policies - in science as in other areas - can work against globality. The relationship between science and power is no longer a bilateral relationship with political power. Economic power is very important indeed and industry is no longer simply a "consumer" of science - it is now shaping science to some extent. We are told that "globalization" is a no-return process, a development that we cannot shape or influence. This is not acceptable. We cannot accept a purely market-

driven society or a purely market-driven democracy, without any other criteria influencing the path taken.

In your country, nearly two-thirds of research and development is funded by the private sector and almost three-quarters of all research is actually performed by industry. Science-intensive sectors such as the pharmaceutical and agro-food business have undergone multi-national mega-mergers, creating companies with bigger turnovers and financial resources than the annual budgets and currency reserves of some European nations. Scientific knowledge, so long regarded as a public good, is rapidly becoming a private asset. The drive to claim patents in genetic research and biotechnology challenges the principle of the sharing of basic scientific knowledge. It is all right to patent procedures, and products, but not fundamental knowledge. There is a risk today that scientific knowledge will be "privatized" and this will widen the gap dramatically between countries.

UNESCO is committed to raising support for scientific capacity-building, for science education, for science-sharing. This is not an abstract, idealistic principle. It has tangible implications for science itself and for endogenous development - the only development which improves the quality of life. If we want relations with developing countries to be defined by mutual confidence, then we must change radically the present scholarship mechanisms. The best talents leave and do not come back. This kind of brain-drain works against the interests of the receivers and expatriates alike. Return incentives are necessary.

When I speak about human resources, I do not only refer to men. If women remain under-represented in science, a huge reservoir of talent is lost. We need equal numbers of women and an equal spread of women in science. Where are the women full professors? The women directors of research institutes and science policy-makers? The nomination of Rita Colwell as Director of the National Science Foundation sets an example for the world. Still on the problem of inequality - if whole continents are virtually excluded from the powerful science networks, huge reservoirs of creativity are being lost. Does North America, whose scientists have at their disposal almost 40% of the world's R&D investment, really need to co-operate with Africa, which has only 0.5% of the total?

I am absolutely convinced that the answer is "yes". What would it mean if, in a programme like UNESCO's Man and the Biosphere, only one or two regions of the world, however powerful their science sectors, took part? Can political frontiers block our co-operation on "El Niño", on global climate change and on protecting our oceans and our air ?

Can the progress made in AIDS treatment be restricted to the advanced countries ? Of course, morally no. But no in practical terms too, as the proliferation of the virus can produce mutants that will boomerang. All countries, regardless of their situation, need to have at least a core of scientists in order to exploit their own resources, to promote a science and technology policy, to encourage industry. Today, with networking facilities, the capacities of these "core groups" can be highly enhanced. The AAAS can play a major role in this respect.

Today, faced by the threats of global warming, the threats of water-related conflicts, all the actors are significant. Can we tell the developing world that it cannot have our levels of commodity consumption, our life-style, our science and technology ? The only acceptable way forward is to get together to forge a global response on such issues, based on sound scientific principles. At UNESCO, whether the subject is ocean observation, or fresh water availability, we work in global partnership on these matters and, as you know, American scientists are active partners in our programmes.

American scientists have been at the forefront of the trend towards assuming greater ethical responsibility and policy-advising roles. It was at Asilomar that Paul Berg and other scientists warned on genetic transformation - and the scientific community was quite right. There can no longer be any doubt that the scientific community here, as elsewhere, is aware of its great responsibilities. This focus on the human and social implications of scientific research has given rise to a new attitude: ethical factors are becoming an integral part of the development of scientific research strategies. Who should determine the priorities and choices of science and technology? On the basis of which social goals? How can we define democratically the risks which can be considered as "acceptable"? What is the level of responsibility and solidarity which can be expected from individuals and groups in relation to both present and future generations?

Such ethical reflection calls for a free and open exchange of experience and ideas between scientists, decision-makers and representatives of civil society in all its diversity. Together, they can identify the issues, set points of reference and advocate a range of forward-looking options. Farsightedness can replace the short-sighted way of action. The solution, here again, lies in democracy. The key is freedom. It is to count and not only to be counted: to take part in decision-making rather than submit passively to decisions which come from above. Democracy is the only conceptual framework for overcoming the age-old and counter-

productive polarization of the debate on science and society. A polarization of seemingly irreconcilable opposites. Facts versus values. Truth versus ethics. Knowledge versus feeling. Science versus religion. Power versus creative freedom. We must dare to know and know to dare.

Straw-poll democracy, the "yes or no" referendum, are not the way to proceed on such fundamental and complex matters. One of the most crucial debates on the need for ethical safeguards in regard to scientific progress is to be found today in the field of genetics. For over four years, UNESCO's International Bioethics Committee explored this question under the very able leadership of Mrs Noëlle Lenoir, member of the French Constitutional Council. It heard the broadest possible spectrum of opinions, held public debates, and - I emphasize this - it ensured that views from all parts of the world, reflecting a great diversity of cultures and spiritual traditions, were recorded. Then last November, the General Conference of UNESCO adopted a Universal Declaration on the Human Genome and Human Rights.

This Declaration provides a consistent and comprehensive set of ethical principles to guide both research and applications of research findings in biology and medicine. As you probably know, its provisions rule out reproductive human cloning. This issue creates great controversy here and elsewhere. I would like to highlight a point which seems to me to be crucial on this matter. An ethics of respect for each individual rules out cloning, as it gives one person the power to determine the identity - the individuality - of another. The Declaration on the Human Genome was adopted by the 186 Member States of UNESCO. It is now up to each sovereign state to translate its provisions into national policy, laws and regulations. A global position on the ethics of a scientific application is highly desirable, as it permits a well-oriented national application.

In these sensitive areas, ethics committees have now established themselves as a permanent part of the landscape. There is in this respect also a growing awareness of the inherent qualities of science. It does not state mere certainties. It constantly challenges itself. The principle of uncertainty lies at the heart of scientific discoveries. It is also at the roots of the freedom of scientific research and therefore of its creativity. It is in this balance between doubt and certainty that the ethics of scientific rigour plays its role.

UNESCO is counting on this particular attitude of scientists - always searching, always self-critical, able to listen and engage in team-work - for its next initiative in the area of the social and ethical responsibility of science. The World Commission on the Ethics of Scientific Knowledge and Technology which I proposed at the last session of the General Conference of UNESCO is about to commence its activities. I have appointed as the Chair of this Commission, Mrs. Vigdis Finnbogadottir, former President of Iceland.

It will be the task of the World Commission, as a forum of reflection, to formulate principles that provide decision-makers, in sensitive areas, with selection criteria that are other than purely economic. The World Commission will be an intellectual forum for the exchange of ideas and experience. It will seek to detect the early signs of risk situations and advise decision-makers accordingly, it will ask the best specialists in the world to participate. It will also promote dialogue between scientists, decision-makers and the public. This kind of *agora* bridges hyper-specialization and encourages scientists to examine each broad field together. The first topics on the Commission's agenda are the ethics of energy, the ethics of the use of freshwater resources and the ethics of the information society.

All such initiatives would be meaningless if we did not pursue another vital goal: the universal popularization of science. An improved understanding of science and technology is important for anyone living in a scientifically and technologically oriented society. The more knowledgeable citizens are, the more active they can be in the increasingly sophisticated society in which they live. Writing in 1782, that American man of politics James Madison said: *"Knowledge will forever govern ignorance: and a people who mean to be their own Governors must arm themselves with the power which knowledge brings"*. That remains true in today's world - one in which we have seemingly limitless information yet, paradoxically in this so-called 'knowledge society', not enough knowledge.

UNESCO's third World Science Report has just appeared. Today it was launched at the National Academy of Sciences. In any democratic society, citizens have the right to influence decisions that are taken on a wide variety of matters on which they have an interest. Science is a matter on which the citizens have an interest. If the general public is to have a voice in scientific decision-making, then it had better know something about the science whose future it is helping to decide. In other words, a science-literate public is an empowered public. There is no ethics

without memory, without a global and prospective vision. Scientists must help people - particularly younger ones - to be aware of what they have and enjoy. Much has been written - and indeed accomplished - in the area of scientific literacy.

The American Association for the Advancement of Science, your organization, is a remarkable example to us all. Throughout its 150 years' existence, the AAAS has had as one of its primary goals, the increase in public understanding and appreciation of science. It has given remarkable service - within the United States and in the wider sphere - in bringing science, and the results of the scientific venture, closer to the general public. 1848 is a date that evokes so much: the springtime of peoples, experiments in democracy, the assertion of cultural identity and the abolition of slavery in France. Science - and scientists like Arago - took the lead. Here in America, the scientific community joined with others like Emerson and Thoreau in demanding an end to slavery. In fact, in the very heat of your Civil War, Abraham Lincoln established the National Academy of Sciences and proclaimed both the emancipation of the slaves and the creation of a federally endowed system of public, state universities dedicated to the spread of knowledge. The date was 1862.

An informed public of active citizens can be a great asset both to the scientific community and to society as a whole. Ignorance can lead to fear, with the risk of a backlash against science.

Ladies and Gentlemen,

I said at the start: the world needs science. And science is in need of increased support - in particular from national administrations - so that we scientists can honour our commitments. But do we honour them? My eldest granddaughter, very interested in environmental issues, asked me once "why are we not implementing our solemn promises made at the Earth Summit?" Government support for science must re-think its approach, as the balance is changing between longer-term, fundamental research and the shorter term and strategic activities favoured by the industrial sector. At the same time, there is a general demand for science to respond better to society's needs and expectations.

It is, in short, time for a new social contract between science and society: a contract that will ensure that scientific knowledge is used to inform management and policy decisions, that science addresses the basic problems of the next century better - health, water, urban transport and so

forth - and that it provide the basis for socially equitable and sustainable development. UNESCO is organizing, in partnership with the International Council of Scientific Unions (ICSU), a World Conference on Science for the Twenty-first Century to be held in Budapest in June of next year. It will be a forum at which scientists, decision-makers and other stake-holders can address the major issues at the interface between science and society together, and negotiate this new social contract. Nothing less than a renewed commitment *towards* science and *by* science will do.

Commitment is a two-sided coin. Science seeks the commitment of politicians to investment and support. Society requires a commitment by the scientific community towards meeting its needs and expectations. The roles of science itself have not changed, but the needs of society have changed radically in recent years. The science of the twenty-first century will need to confront complex problems of truly global scale. It will have to be interdisciplinary in approach, drawing not just on the natural sciences but also on the social sciences and the humanities, as I said earlier. It will need international co-operation to meet the research and training requirements of tomorrow. And it will need scientists to combine their tradition of carefree, exploratory rationality with a new rationality of responsibility for others.

I am confident that the World Conference will prove to be a watershed event, redefining the relationship between those who carry out science and those who have political power. Such an attempt to bring about this Renaissance of science demands the utmost creativity on the part of all concerned. The AAAS can play a very important role, particularly in the follow-up, opening out to all the world. You are in the vanguard. Our ambition is to make UNESCO a global space for scientific interaction and sharing. I invite you to join us in this venture. Science means free enquiry. Science means intellectual freedom and the moral solidarity of mankind. But science also means reaching beyond the boundaries of our specialties and indeed beyond science to the educational, cultural and communications challenges that mark our time.

UNESCO's priorities, UNESCO's achievements, UNESCO's catalyzing roles all aim to create peace and security through teaching and learning, sharing and caring. Science is central to education for all throughout life. Science is central to cultural preservation and cultural diversity. Science is central to the free flow of information, the ethics - and the potential - of the Internet. Science is central to the bond that unites the living with generations

yet to come. The Culture of Peace is the rigour of science and the power of our commitment to devise new ways of promoting democracy, freedom and tolerance throughout the world. In all of this, UNESCO is building the bridges. We ask the American scientific community and its friends and allies in American intellectual, political and cultural life to join with us.

In conclusion, let me say that this new contract can contribute to a thriving democracy, the democracy of the 21st Century: a democracy where scientists ask "why?" and "what for?" and indeed "why not?," not only of the natural world but of their communities. They will play a central role in that new democracy. They will play a central role in the transition from a culture of war and conflict to a culture of non-violence and peace.